

MARINE GEOSCIENCES

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Geological Studies in the Capricorn and Bunker Reefs

PERIOD: 1978

ORGANIZATION: Bureau of Mineral Resources, Geology and Geophysics

PROJECT LEADER: Dr P. Davies

FINANCIAL SUPPORT: GBRMPA - \$4,000

OBJECTIVES

To understand processes affecting past and present growth of reefs and islands.

IMPLICATIONS/MANAGEMENT NEEDS

An age classification of reefs could assist in management: juvenile reefs and senile reefs may not be able to withstand sedimentation to the same extent as mature reefs; mature reefs may cope more easily with sedimentation compared with senile reefs which are choked with sediment.

METHODOLOGY

Multidisciplinary geological/hydrological/geobiological studies were conducted in Capricornia between 1975 and 1978 by scientists of the Bureau of Mineral Resources and collaborating institutions. Four reefs were studied in detail (One Tree, Fitzroy, Wreck and Fairfax) and reconnaissance studies were also carried out on most of the other reefs of the Capricorn and Bunker Groups. Effective comparisons with the reefs studied in detail can therefore be made.

STATUS

The project has been completed.

A classification of reefs from juvenile (Llewellyn Reef), mature (One Tree Reef, Fitzroy Reef) through to senile reefs (Wreck, Fairfax Reefs) was determined based on lagoon, particle size, margins, reef top, island progradation characteristics etc.

LOCALITY: Capricornia Section

Circulation and Sediment in Platform Reef Lagoons, using One Tree as an Example

PERIOD: 1979

ORGANIZATION: University of Sydney, Department of Geography

PROJECT LEADER: Ms C. Ludington

PROJECT OFFICER: Dr W. Craik

SUPERVISOR: Dr A. Short

FINANCIAL SUPPORT: GBRMPA Augmentative Research Grant - \$750

OBJECTIVES

To define and investigate the major factors influencing water circulation in platform reef lagoons.

To investigate the relationships between circulation, reef morphology and sediments distribution on a small scale.

IMPLICATIONS/MANAGEMENT NEEDS

This study is designed to provide a greater understanding of the effects of natural phenomena on the reef. It will provide greater information on small scale circulation.

METHODOLOGY

Field work involved: (i) the continuous recording of current over a four week period; (ii) the release of drogues over 20 tide cycles; (iii) two major dye releases traced for 3 days each; (iv) eight weeks recording of tidal fluctuations; (v) several small scale dye releases; and (vi) in-situ current measurements over 5 tide cycles.

Sediment samples were analysed at the Bureau of Mineral Resources in Canberra.

STATUS

The project has been completed.

Wind speed and direction and swell direction are the most important variables influencing circulation, except in the critical stages of the tide when the outside tide is just rising above or falling below the crest.

Total lagoon flushing is achieved in approximately 5 to 6 tides (2.5 to 3 days), but surface water can be exchanged in a single tide.

Papers on this research have been published:

Ludington, C.A. 1979. Tidal modifications and associated circulation in a platform reef lagoon. *Aust. J. Mar. Freshwater Res.*, 30: 425-430.

Ludington, C.A. 1981. A study of flushing and exchange in reef lagoons, using fluorescent dye. Proceedings of 3rd Conference on Environmental Engineering, Townsville, July 1981. The Institution of Engineers, a National Conference Publ. No. 81/6. pp 102-106.

Frith (nee Ludington), C.A. In press. Lagoon Circulation, One Tree Reef, Southern Great Barrier Reef. Proceedings of 4th International Coral Reef Symposium, Manila, May 1981.

Hatcher, A. and Frith, C.A. In prep. The control and maintenance of the standing stock of dissolved inorganic Nitrogen in a coral reef lagoon.

Frith, C.A. and Mason, L. In prep. A depth-integrated model of circulation, One Tree Reef, Southern Great Barrier Reef.

LOCALITY: Capricornia Section - One Tree Island Reef

Paleoclimate and Dating Studies: The Development of Sand Cays in the Capricorn and Bunker Groups

PERIOD: 1979

ORGANIZATION: University of Queensland, Department of Geology

PROJECT LEADER: Dr P. Flood

PROJECT OFFICER: Dr W. Craik

FINANCIAL SUPPORT: GBRMPA Augmentative Research Grant - \$675

OBJECTIVES

To explain the development of sand cays in terms of changing sea levels and temperatures, changing climatic patterns, relationships between islands on reefs, and the effects of lunar interference.

IMPLICATIONS/MANAGEMENT NEEDS

This study is designed to determine changes in island shape due to natural phenomena.

METHODOLOGY

Beach profiles were measured to determine seasonal and long term fluctuations in island shape.

Samples of *Tridacna* (clam) were collected from lithified beach ridges for radiocarbon dating and determination of paleotemperatures of seawater at the time of skeletal deposition.

STATUS

The project has been completed.

It was apparent from radiocarbon dating and isotope analysis that sea level was slightly higher than the present level at 4850 years ago. Sea level fell from above its present level between 3050 to 2750 years. A fall of slightly less than 1 metre is indicated.

Lithification of the cay sediment has been occurring at least up to 520 years ago. Subsequent to about 500 years ago the sea level appears to have remained at about present level except perhaps for a relatively recent rise of the order of a few centimetres which has been occurring during the past 40-50 years.

The following publications report on aspects of this study:

Flood, P.G., Harjanto, S., and Orme, G.R. 1979. Carbon-14 dates, Lady Elliot Reef, Great Barrier Reef. *Queensland Government Mining Journal* 80(935):444-447.

Flood, P.G. 1980. Geomorphology of Tryon Island and Reef. *Queensland Nat.* 23, 113-126.

Orme, G.R. & Flood, P.G. 1980. Sedimentation in the Great Barrier Reef Province, Adjacent Bays and Estuaries; in Henderson, R.A. & Stephenson, P.J. (eds), *The Geology and Geophysics of Northeastern Australia*. Geol. Soc. Aust. Qld. Div. Brisbane, 419-434.

Gourlay, M.R. & Flood, P.G. 1981. Impact on coastal engineering works upon a coral cay: Heron Island. *Confr. on Environmental Engineering*, Townsville, 159-163.

Flood, P.G. 1979. Heron Island Erosion Problems. *Reflections* 3, 4.

——. 1980. Cyclone "Simon" Changes Cays. *Reflections* 3, 4.

——. 1981. Coral Cays and Cyclones. *Beach Conservation* 42, 6.

——. 1981. Bioclastic Carbonate Facies of the Great Barrier Reef, Australia. *Amer. Assoc. Petrol. Geol.* 65(5), 926.

——. 1981. A record of the shoreline changes to 1980 on cays of the Capricorn Group, Southern Great Barrier Reef, Australia. Dept. Geology, University of New England, 50 p.

——. 1981. Bioclastic Carbonate Sediments of the Great Barrier Reef, Australia. Fifth Australian Geological Convention - Sediments Through the Ages. Abstract, 46.

Flood, P.G. 1981. Geological Guide to Lady Elliot Reef. Prepared in conjunction with the Great Barrier Reef Committee and Royal Society of Queensland Symposium: the Capricornia Section of the Great Barrier Reef Marine Park - Past, Present and Future. 17 p.

———. In press. The variability of shoreline position on five uninhabited islands of the Capricorn Group, southern Great Barrier Reef, Symposium organized by Great Barrier Reef Committee and Royal Society of Queensland, Brisbane, September 1981.

———. In press. Holocene Sea Level Data from the Southern Great Barrier Reef and Southeastern Queensland: A review in HOPLEY, D. *Australian Sea Levels in the Last 15,000 Years*. A Report for International Geological Correlation Program 61.

LOCALITY: Capricornia Section

6 Study of Reef Top Sediments on Wreck Reef

PERIOD: 1981
ORGANIZATION: University of New England, Department of Geology
PROJECT LEADER: Mr G. Brown
PROJECT OFFICER: Dr W. Craik
SUPERVISOR: Dr P. Flood
FINANCIAL SUPPORT: GBRMPA Augmentative Research Grant - \$600

OBJECTIVES

To determine relationships of reef sediments to reef maturity.
To relate findings to hypothetical schemes on reef evolution.

IMPLICATIONS/MANAGEMENT NEEDS

Information is required about the distribution of sediments of the Region to establish baseline distributions for monitoring and to decide what changes are natural.

METHODOLOGY

Approximately 150 surface sediment samples were collected in transects across Wreck Island Reef. These were analysed for the proportions of coral material, etc.

STATUS

The project has been completed.

The typical component composition of the reef flat sediments was:

	coral	coralline algae	molluscs	benthic foraminiferans
av. %	25	42	9	23
range %	8-75	5-50	1-16	14-32

The beach sediments had a similar composition. The dune sediments on the cay varied only with slightly higher proportions of coral material. The various textural parameters (mean size, modal size, sorting, skewness and kurtosis) displayed a marked correspondence to the physiographic zonation.

There is an obvious relationship between the increase in the percentage of foraminiferids in the sediments of Wreck Reef when compared to their distribution in sediments of Heron and Lady Musgrave Reefs. Obviously the time that a reef has to interact with the prevailing physical environment at the sea/air interface the more pronounced is the physiographic zonation which is developed. A consequence of this is that the organisms on the reef top progressively change from frame building organisms such as corals to either calcareous algae which cement over the reef top or to soft tissue organisms such as algae, sponges etc. which support an abundant epiphytic fauna of foraminiferids etc.

The implication for management is that a reef such as Wreck is not static; it is in dynamic equilibrium with the prevailing physical forces and given adequate time (hundreds or perhaps thousands of years) it will gradually change.

In the short term, however, little change is likely to occur. The reef has experienced several major cyclones during the past decade. These have done little to change the physiography of the reef or island. The distribution of sediment on the reef flat has remained static other than that it appears to be gradually coarsening.

Flood, P.G. 1981. Skeletal component and grain size composition of sediments on Wreck Reef, Capricornia Section, Great Barrier Reef Marine Park. Report to the Great Barrier Reef Marine Park Authority.

LOCALITY: Capricornia Section - Wreck Island Reef

Lagoonal Sedimentation: One Tree Island Reef**PERIOD:** 1981**ORGANIZATION:** University of Sydney,
Department of Geology and Geophysics**PROJECT LEADER:** Mr W. Kiene**PROJECT OFFICER:** Dr W. Craik**SUPERVISOR:** Dr E. Frankel**FINANCIAL SUPPORT:** GBRMPA Augmentative Research Grant - \$600**OBJECTIVES**

To define the 3-D facies geometry of lagoonal sediments at One Tree Island Reef.

To develop relationship between temporal variations in flora and fauna remains in sediment and variations in environmental and ecological parameters.

To determine estimates of patch reef sediment contribution to lagoonal infill.

IMPLICATIONS/MANAGEMENT NEEDS

Information is required about the distribution of sediments to establish baseline data for monitoring, to quantify the contributions of terrigenous and reefal sediments to the Great Barrier Reef lagoon, and to decide whether changes in sedimentary facies are natural or forced by impacts.

IMPLICATIONS/MANAGEMENT NEEDS

The coarse fractions of skeletal sediments were sampled, using an air lift, throughout the lagoon at various levels in the subsurface.

STATUS

The project has been completed.

Findings show the concentration of gravel size material is related to dominant sediment source. Areas dominated by autochthonous sedimentation show higher concentrations of gravel in air lifted samples. In areas dominated by allochthonous sedimentation, samples show less gravel.

Allochthonous sedimentation is seen to dominate on windward sand sheets. Vertical sampling shows a temporal progradation of these sand sheets over lagoonal sediments. Skeletal constituents of finer sizes show the decrease of *Halimeda* and foraminifera debris away from the windward margin. This distribution of constituents suggests transportation from a source to a sink under a hydrodynamic regime of energy dissipation.

Extensive patch reef development provides local sources for autochthonous gravel. Coralline algae dominates on linear reticulate patch reefs in windward lagoonal areas. This coralline algae dominance may reflect higher energy and sedimentation in windward areas. *Acropora* coral growth is not well developed in windward lagoonal areas but is extensive in leeward areas. *Acropora* rubble was found in the subsurface in an area that does not support the growth today. This temporal change may result from exclusion of *Acropora* in windward lagoonal areas by unfavorable environmental conditions. These unfavorable conditions may be created by the zone of allochthonous sedimentation moving into the lagoon.

LOCALITY: Capricornia Section - One Tree Island Reef

8 Study of the Fringing Reef at Orpheus Island

PERIOD: 1981

ORGANIZATION: James Cook University, Department of Geography

PROJECT LEADER: Ms A. Slocombe

PROJECT OFFICER: Dr W. Craik

SUPERVISOR: Assoc. Prof. D. Hopley

FINANCIAL SUPPORT: GBRMPA Augmentative Research Grant - \$640

OBJECTIVES

To determine the nature and depth of reef foundations, growth rates of the reef, geochemical change in the fossil reef which may indicate environmental alterations, and if any alterations are due to European settlement in the last 100 years.

IMPLICATIONS/MANAGEMENT NEEDS

This study is designed to examine physical and geochemical parameters which may be useful in monitoring the health of a reef system.

METHODOLOGY

Field work involved obtaining cores for use in geochemistry and absolute dating, sampling live corals for the establishment of modern growth rates, echosounding on the reef front and seismic profiling of the reef flat. Laboratory work included the use of x-ray diffraction, atomic absorption spectrophotometric analysis, and colorimetric techniques.

STATUS

The project has been completed.

Dating of cores has revealed that the reef began growth close to shore about 7,000 years B.P., once sea level had begun to stabilise. Rapid growth of the reef followed its initiation with rates of up to 16.7mm/yr being attained. Rates slowed down to 1.1mm/yr once it reached sea level. The inner reef reached modern sea level about 5,000 years B.P., and the outer reef about 1,000 years B.P. Early diagenesis of the reef is suggested by a depletion of Sr in the cores with respect to the modern corals.

Suggestions of salinity variations and a temperature increase are supported by climatic data obtained using pollen analysis of sediment cores from North East Queensland (Kershaw, 1978, 1980), but there has been no significant variation in terrigenous input on the reef.

No changes in terrigenous input resulting from land use on the adjacent mainland were detected. It was concluded that either (i) no changes had occurred in the waters around the reef; (ii) the techniques used could not identify small changes; or (iii) the reef studied may not have been fully affected by mainland run-off.

All three possibilities may be correct. In view of the increasing pressure on coastal lands in North Queensland, it is recommended that further experimental work of this type be carried out to identify easily available physical and geochemical parameters which reflect the health of a reef system.

There is nothing in the evidence provided by this research to suggest that Pioneer Bay fringing reef has been affected by any changes on the mainland brought by European settlement over the last 100 years or so. However, the monitoring of reefs, especially fringing reefs, must become increasingly important in future research if we are to minimise the effects on reefs of pollution, and increased sediment and fresh water input resulting from clearing of land. Only this will ensure that flourishing reefs, such as in Pioneer Bay, are not destroyed.

Slocombe, A.M. 1981. The structure and development of the fringing reef in Pioneer Bay, Orpheus Island. Honours thesis, James Cook University of North Queensland.

LOCALITY: Orpheus Island Reef (Pioneer Bay)

Sea-water Interpretation from Modern and Holocene Corals of the Central Great Barrier Reef: a Spatial and Temporal Perspective

PERIOD: May 1982 - Aug 1983

ORGANIZATION: James Cook University, Geography Department

PROJECT LEADER: Mr F. Muir

PROJECT OFFICER: Dr W. Craik

SUPERVISOR: Assoc. Prof. D. Hopley; Mr R. Kenchington

FINANCIAL SUPPORT: GBRMPA - \$2,500; Augmentative Research Grant: \$200

OBJECTIVES

To predict from present-day and Holocene corals the annual and seasonal ambient sea-water temperatures at the time of coral growth.

To provide a possible interpretation of Holocene sea-water temperatures as they relate to Holocene sea-level variations.

This study is designed to provide an indication of environmental factors influencing coral growth in the Holocene. Temporal variations may be explained by changing climatic and oceanographic factors. Differences between nearshore fringing reef corals and offshore may be evident.

METHODOLOGY

Corals will be collected from present-day living reefs to establish modern thermometry standards against which the corals from submerged Holocene reefs can be compared.

Geochemical analysis and sclerochronology of the modern coral and fossil coral cores will be undertaken. Geochemical analysis will involve interpretation of Sr/Ca ratio levels. These ratios will be related to the sclerochronology density bands and C14 dates.

STATUS

Report to GBRMPA due August 1983.

Radiocarbon Dating of Fantome Island Fringing Reef Corals

PERIOD: May 1982 - Dec 1982

ORGANIZATIONS: James Cook University, Department of Geology
McMaster University, Ontario, Canada

PROJECT LEADERS: Dr D. Johnson
Dr M. Risk (formerly with Australian Institute of Marine
Science)

PROJECT OFFICER: Dr W. Craik

SUPERVISOR: Mr R. Kenchington

FINANCIAL SUPPORT: GBRMPA - \$4,000

OBJECTIVES

To use radiocarbon dating of fringing reef corals to show the pattern of growth over last 5000 years.

IMPLICATIONS/MANAGEMENT NEEDS

This reef has been growing for the past 5000 years over a mud substrate. Growth and maintenance of a viable coral reef may be dependent on sustaining associated detrital deposits.

METHODOLOGY

Radiocarbon dating of 3 cores taken in May 1981 off the northern end of Fantome Reef (in a joint AIMS-Army project) is involved.

STATUS

Report to GBRMPA received and under consideration.

LOCALITY: Fantome Island Fringing Reef (in the Palm Island Group off Ingham)

